

Wind turbines - Part 23: Full-scale structural testing of rotor blades

EVS

EESTI STANDARDI EESSÕNA

NATIONAL FOREWORD

See Eesti standard EVS-EN 61400-23:2014 sisaldab Euroopa standardi EN 61400-23:2014 inglisekeelset teksti.	This Estonian standard EVS-EN 61400-23:2014 consists of the English text of the European standard EN 61400-23:2014.
Standard on jõustunud sellekohase teate avaldamisega EVS Teatajas.	This standard has been endorsed with a notification published in the official bulletin of the Estonian Centre for Standardisation.
Euroopa standardimisorganisatsioonid on teinud Euroopa standardi rahvuslikele liikmetele kättesaadavaks 23.05.2014.	Date of Availability of the European standard is 23.05.2014.
Standard on kättesaadav Eesti Standardikeskusest.	The standard is available from the Estonian Centre for Standardisation.

Tagasisidet standardi sisu kohta on võimalik edastada, kasutades EVS-i veebilehel asuvat tagasiside vormi või saates e-kirja meiliaadressile standardiosakond@evs.ee.

ICS 27.180

Standardite reprodutseerimise ja levitamise õigus kuulub Eesti Standardikeskusele

Andmete paljundamine, taastekitamine, kopeerimine, salvestamine elektroonsesse süsteemi või edastamine ükskõik millises vormis või millisel teel ilma Eesti Standardikeskuse kirjaliku loata on keelatud.

Kui Teil on küsimusi standardite autorikaitse kohta, võtke palun ühendust Eesti Standardikeskusega:
Aru 10, 10317 Tallinn, Eesti; www.evs.ee; telefon 605 5050; e-post info@evs.ee

The right to reproduce and distribute standards belongs to the Estonian Centre for Standardisation

No part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying, without a written permission from the Estonian Centre for Standardisation.

If you have any questions about copyright, please contact Estonian Centre for Standardisation:
Aru 10, 10317 Tallinn, Estonia; www.evs.ee; phone 605 5050; e-mail info@evs.ee

English Version

**Wind turbines - Part 23: Full-scale structural testing
of rotor blades
(IEC 61400-23:2014)**

Éoliennes - Partie 23: Essais en vraie grandeur
des structures des pales de rotor
(CEI 61400-23:2014)

Windenergieanlagen - Teil 23: Rotorblätter -
Experimentelle Strukturprüfung
(IEC 61400-23:2014)

This European Standard was approved by CENELEC on 2014-05-13. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.



European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

Foreword

The text of document 88/420/CDV, future edition 1 of IEC 61400-23, prepared by IEC TC 88 "Wind turbines" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 61400-23:2014.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2015-02-13
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2017-05-13

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61400-23:2014 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61400-22	NOTE	Harmonised as EN 61400-22 (not modified).
--------------	------	---

EVS

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050-415	1999	International Electrotechnical Vocabulary - Part 415: Wind turbine generator systems	-	-
IEC 61400-1	2005	Wind turbines - Part 1: Design requirements	EN 61400-1	2005
ISO/IEC 17025	2005	General requirements for the competence of testing and calibration laboratories	EN ISO/IEC 17025	2005
ISO 2394	1986	General principles on reliability for structures	-	-

EVS

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	8
3 Terms and definitions	9
4 Notation.....	12
4.1 Symbols.....	12
4.2 Greek symbols.....	12
4.3 Subscripts.....	12
4.4 Coordinate systems	12
5 General principles	13
5.1 Purpose of tests.....	13
5.2 Limit states	14
5.3 Practical constraints	14
5.4 Results of test.....	14
6 Documentation and procedures for test blade.....	15
7 Blade test program and test plans	16
7.1 Areas to be tested.....	16
7.2 Test program	16
7.3 Test plans.....	16
7.3.1 General	16
7.3.2 Blade description	16
7.3.3 Loads and conditions.....	17
7.3.4 Instrumentation.....	17
7.3.5 Expected test results	17
8 Load factors for testing.....	17
8.1 General.....	17
8.2 Partial safety factors used in the design.....	17
8.2.1 General	17
8.2.2 Partial factors on materials	17
8.2.3 Partial factors for consequences of failure	18
8.2.4 Partial factors on loads	18
8.3 Test load factors	18
8.3.1 Blade to blade variation	18
8.3.2 Possible errors in the fatigue formulation	18
8.3.3 Environmental conditions.....	19
8.4 Application of load factors to obtain the target load	19
9 Test loading and test load evaluation.....	20
9.1 General.....	20
9.2 Influence of load introduction	20
9.3 Static load testing	20
9.4 Fatigue load testing	21
10 Test requirements.....	22
10.1 General.....	22
10.1.1 Test records	22
10.1.2 Instrumentation calibration.....	22

10.1.3	Measurement uncertainties	22
10.1.4	Root fixture and test stand requirements	22
10.1.5	Environmental conditions monitoring	22
10.1.6	Deterministic corrections	23
10.2	Static test	23
10.2.1	General	23
10.2.2	Static load test.....	23
10.2.3	Strain measurement	24
10.2.4	Deflection measurement	24
10.3	Fatigue test.....	24
10.4	Other blade property tests	24
10.4.1	Blade mass and center of gravity	24
10.4.2	Natural frequencies	25
10.4.3	Optional blade property tests	25
11	Test results evaluation.....	25
11.1	General.....	25
11.2	Catastrophic failure.....	25
11.3	Permanent deformation, loss of stiffness or change in other blade properties	26
11.4	Superficial damage	26
11.5	Failure evaluation	26
12	Reporting	26
12.1	General.....	26
12.2	Test report content.....	27
12.3	Evaluation of test in relation to design requirements	27
Annex A (informative)	Guidelines for the necessity of renewed static and fatigue testing	28
Annex B (informative)	Areas to be tested	29
Annex C (informative)	Effects of large deflections and load direction	30
Annex D (informative)	Formulation of test load	31
D.1	Static target load.....	31
D.2	Fatigue target load.....	31
D.3	Sequential single-axial, single location.....	34
D.4	Multi axial single location	34
Annex E (informative)	Differences between design and test load conditions.....	36
E.1	General.....	36
E.2	Load introduction	36
E.3	Bending moments and shear.....	36
E.4	Flapwise and lead-lag combinations.....	36
E.5	Radial loads.....	37
E.6	Torsion loads	37
E.7	Environmental conditions	37
E.8	Fatigue load spectrum and sequence	37
Annex F (informative)	Determination of number of load cycles for fatigue tests	38
F.1	General.....	38
F.2	Background	38
F.3	The approach used	38
Bibliography		43

Figure 1 – Chordwise (flatwise, edgewise) coordinate system	13
Figure 2 – Rotor (flapwise, lead-lag) coordinate system	13
Figure C.1 – Applied loads effects due to blade deformation and angulation	30
Figure D.1 – Polar plot of the load envelope from a typical blade	31
Figure D.2 – Design FSF	33
Figure D.3 – Area where design FSF is smaller than 1,4 (critical area)	33
Figure D.4 – $rFSF$ and critical areas, sequential single-axial test	34
Figure D.5 – $rFSF$ and critical area, multi axial test	35
Figure E.1 – Difference of moment distribution for target and actual test load	36
Figure F.1 – Simplified Goodman diagram	39
Figure F.2 – Test load factor γ_{ef} for different number of load cycles in the test	42
Table 1 – Recommended values for γ_{ef} for different number of load cycles	18
Table A.1 – Examples of situations typically requiring or not requiring renewed testing	28
Table F.1 – Recommended values for γ_{ef} for different number of load cycles	38
Table F.2 – Expanded recommended values for γ_{ef} for different number of load cycles	41

INTRODUCTION

The blades of a wind turbine rotor are generally regarded as one of the most critical components of the wind turbine system. In this standard, the demands for full-scale structural testing related to certification are defined as well as the interpretation and evaluation of test results.

Specific testing methods or set-ups for testing are not demanded or included as full-scale blade testing methods historically have developed independently in different countries and laboratories.

Furthermore, demands for tests determining blade properties are included in this standard in order to validate some vital design assumptions used as inputs for the design load calculations.

Any of the requirements of this standard may be altered if it can be suitably demonstrated that the safety of the system is not compromised.

The standard is based on IEC TS 61400-23 published in 2001. Compared to the TS, this standard only describes load based testing and is condensed to describe the general principles and demands.